Service Guide

07/2012

LANDAUER®

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Welcome to Landauer Dosimetry Service

Landauer basic radiation dosimetry service includes automatic exchange out of dosimeters each wear period, processing and analysis of dosimeters, data management, archival storage of exposure results, standard radiation dosimetry reports, with customer service and technical support programs.

An Overview of How Landauer Provides Your Dosimetry Service

1. You contact Landauer with your order and your request is entered into our computer system. The computer accesses, checks and updates your account.

2. Our computer system generates instructions to create a dosimeter for your next and successive scheduled wear period shipments. Serial numbers are assigned to dosimeters.

3. We assemble the dosimeter, print the packing list, and ship your order to arrive at your location just before the beginning of the wear period. We include a control dosimeter with the shipment to monitor exposure in transit and storage.

4. You receive your shipment and distribute the dosimeter for use. After use at the end of the wear period, you replace the used dosimeter with the dosimeter for the new wear period, and return the used dosimeter along with the control dosimeter of the same wear date to Landauer for processing.

5. Our Receiving Department at Landauer logs in all incoming dosimeters into our computer system and assigns an analytical work order number for tracking.

6. We analyze the dosimeter, review the results, then report, merge and verify for completeness the results from all separate dosimeter types.

7. We permanently archive all exposure results, print and then mail your dosimetry report to you; or you can go paperless and retrieve reports from our online service, myLDR. Online report retrieval is available for all reporting services.

Available Technical Support

Corporate Office:
Landauer, Inc
2 Science Road
Glenwood, IL 60425

Luxel+
Phone: (708) 755-7000
Toll Free Phone: (800) 323-8830
Customer Service: custserv@landauer.com
Technical: csrecords@landauer.com
Web Site: www.landauer.com

InLight
Toll Free Phone: (800) 561-2708

Optional Features

Throughout this Service Guide optional features appear. Optional features are services or products not automatically supplied with our basic dosimetry service. Each optional feature is available by contacting Customer Service, and may involve an additional fee or charge designated by [$].

Shipment Contents

Your shipment contains a packing list, dosimeters, holders if applicable, a control dosimeter(s) for each dosimeter type, and a return envelope or label to be used to return your dosimeter(s) to our laboratory for processing.

All routine shipments from Landauer, Inc. to the client are F.O.B. (Free on Board) destination via first class mail. A request for overnight delivery will incur a minimum fee per package for handling and shipping. Return shipment fees are paid by customer.

Optional Feature: Shipments to Multiple Sites

All routine shipments are sent to a central location or can be sent to multiple sites (subaccounts/series) at the same address or to different addresses. A subaccount/series within an account is segregated on dosimetry reports, and the subaccount/series name or code appears on the dosimeter. [$]

Optional Feature: Shipment Tracking Online

Check the order status of your shipment online or log-in to Landauer's web site and track when, where and how your shipment was sent. Details such as wear period, frequency, series, quantity of dosimeters shipped, shipping charges, carrier, and tracking number if applicable, can be viewed anytime you have access to the Internet. (See Landauer's Web Site www.landauer.com for log-in information.)

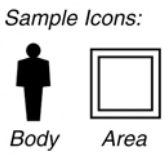
Optional Feature: Email Notifications

Landauer can automatically send you an email notification when new shipping information and all reports are available to view online through myLDR.

Dosimeter Use

Use the dosimeter(s) beginning on the wear date or as close to that date as possible.

An icon on the face of the Luxel+® and InLight® dosimeters identifies the correct placement of the dosimeter. Icons include whole body and extremity use, area monitoring, and a special icon designed for fetal monitoring.



Wear personnel dosimeters with the icon facing away from the body. Wear the ring dosimeter on a finger on the hand indicated on the ring cover.

Personnel dosimeters should be worn during working hours to record occupational exposure **NOTE:** Do not wear dosimeters during non-working hours while undergoing diagnostic or medical procedures where exposures would not be part of your occupational exposure history.

At the end of the wear period, return to Landauer all used and unused dosimeters for processing and determination of dose. Include in the return shipment any control dosimeter(s) that accompanies the dosimeters in transit and storage.

Control Dosimeters

A separate dosimeter known as a control dosimeter is included with each shipment to monitor radiation received in transit or storage. The control dosimeter exposure can be subtracted from each individual dosimeter exposure in the shipment to separate the occupational dose from the background exposure.

The control dosimeter(s) assigned to a shipment should accompany that shipment in transit both from and to Landauer. Do not use the control dosimeter for any other purpose.

Store control dosimeters away from radiation with dosimeters of the same type and wear date when not in use (do not store dosimeters near a radioactive source or in a x-ray room). Control dosimeters have the participant number with 5 zeros for the account and series/subaccount with number 00RAD imbedded in the participant number.

Landauer automatically supplies a control dosimeter for each account, and can supply additional control dosimeters for each account, and can supply additional control dosimeters to help you structure your program for control handling. For example, if you return dosimeters in many shipments instead of one, we can arrange to routinely invoice additional control dosimeters so that you can include a control dosimeter with each shipment returned separately to Landauer for processing.

Optional Feature: Subaccount/Series Control Dosimeter

If you have elected to set up a subaccount/series (department grouping) for your account and you store each department's dosimeters at a different location at your facility, we can supply a control dosimeter to accompany each department grouping, with or without a master control dosimeter for each account.

Optional Feature: Control Dosimeter

Landauer can replace multiple subaccount/series control dosimeters with a control dosimeter when we ship all of your dosimeters to one place and they are stored in one location.

Exception: If a control dosimeter exposure is higher than expected or higher than the majority of the exposures received by the dosimeters in the shipment, the control dosimeter exposure is not subtracted. In such an event, it is noted at the bottom of the dosimetry report that the control dosimeter was not used in the assessment of the reported exposure results.

Optional Feature: Automatic Background Subtraction NCRP No. 94

Landauer can arrange to automatically subtract a calculated average background exposure from the dosimeters in your shipment when a valid control dosimeter is not available. The

service calculates a fraction of a millirem per day that totals approximately six mrem (sixty mSv) per month starting from the manufacturing date of the dosimeter and ending with the read out date. The formula for this service is based on the data presented in the NCRP Report No. 94 "Exposure of the Population in the United State and Canada from Natural Background Radiation" published in 1988 by the National Council on Radiation Protection and Measurements.

Optional Feature: Automatic Custom Background Subtraction

Landauer can arrange to automatically subtract a customer-defined background exposure from the dosimeters in your shipment when a valid control dosimeter is not available.

Optional Feature: No Background Subtraction

Landauer can arrange to not subtract the control exposure from the dosimeters in your shipment.

Feature: Report Control Exposure

Landauer can arrange to report the control exposure used in the background subtraction from the dosimeters in your shipment.

Landauer's standard background control subtraction hierarchy is as follows: Modifications can be made upon request.

1. Use valid control badge from subaccount/series or master control
2. If no valid control is available, the automatic background subtraction constant is used. Client can set up a "customer defined" background subtraction constant to be used in place of the Landauer default.
3. Client can elect to not have the control subtracted.

Luxel® + Dosimetry Service

Luxel+ may be packaged for personnel monitoring, area monitoring, emergency response or other specialized services. Standard packaging ships each dosimeter individually wrapped in cellophane along with a card containing account and worker information. Holders are packaged separately. Remove the dosimeter from the cellophane, snap the dosimeter into holder for use, and discard the cellophane.

At the end of the wear period, snap the used dosimeter out of the holder and replace it with the dosimeter for the new wear period.

Return the used dosimeter along with the control dosimeter(s) of the same wear date to Landauer to process for exposure.

Do not return used dosimeters in cellophane packaging. Landauer receives and reports all Luxel+ dosimeters returned in their original cellophane wrapper as unused (excluding control dosimeters).

Store dosimeters away from radiation when not in use (do not store near a radioactive source or in a x-ray room).

Information printed on each Luxel® + dosimeter

Luxel + Front Examples

Luxel + Back

Ring Dosimetry Service

Landauer ships rings in a plastic bag along with the control dosimeter. Remove ring(s) from bag for use.

Store dosimeters away from radiation when not in use (do not store near a radioactive source or in a x-ray room). Return the used ring along with the ring control dosimeter(s) of the same wear date to process for exposure.

Ring sizes are available in small, medium, large and extra large with the default being medium if no size is specified

InLight® Dosimetry Service

InLight can be packaged for personnel monitoring, area monitoring, emergency response or other specialized services. Standard packaging ships dosimeters with an attached alligator clip or a slotted clip.

Information found on each InLight dosimeter:

Return the used dosimeter along with the control dosimeter(s) of the same wear date to Landauer to process for exposure.

Environmental Dosimetry Service

The InLight Environmental dosimeter is for both indoor and outdoor use, and is designed to withstand extremes of temperature, humidity, precipitation, and other environmental conditions. The dosimeter is sealed in a heavy-duty vinyl tamper-resistant pouch that has multiple slots to permit several methods of attachment for easy deployment.

InLight's standard environmental dosimetry service 5 mrem (50 uSv) minimal reporting EX, supplies one control to monitor radiation received in transit and storage.

InLight's high-sensitivity environmental dosimetry service reporting down to 0.1 mrem, EX9, requires a minimum of two controls. The first control is for field deployment/retrieval used to measure exposure during shipment and placement/collection. The second control is for transit used to measure exposure during shipment only.

Return the used dosimeter along with the control dosimeter(s) of the same wear date to Landauer to process for exposure.

Return Dosimeters to Landauer for Processing

At the end of the wear period, to process for exposure:

- ❒ Snap Luxel®+ dosimeters out of their holders and return to Landauer the dosimeters along with the control dosimeter(s) of the same wear date (retain the holders). Landauer receives and reports all Luxel+ dosimeters returned in a cellophane wrapper as unused (excluding control dosimeters).
- ❒ Return to Landauer the rings, Neutrak®, InLight® Environmental and/or other dosimeters along with their control dosimeter(s) of the same type and wear date.

If you are returning a duplicate dosimeter(s) for a wear period to obtain credit for the replacement fee, and you do not want the dosimeter(s) reported as unused, return the dosimeter(s) in a bag separate from the regular wear period dosimeters. Please include:

1. List of the dosimeters returned for the replacement fee credit

2. Statement with an authorized signature verifying the dosimeters are being returned for replacement fee credit only, and you do not wish to have them processed and reported as unused.

Unreturned Dosimeters

Return all used and unused dosimeters at the end of each wear period. A dosimeter (including a control dosimeter) is considered lost if it is not returned to Landauer within 90 days after the end wear date. There is a replacement fee for each dosimeter not returned.

A warning report after 45 days will be issued listing the dosimeters that have not been returned.

Emergency Processing [$]

Emergency processing is available for dosimeters suspected of receiving overexposure. Call Customer Service 800-323-8830. Please have the following available:

- ❒ Account number
- ❒ Name and phone number of the person to be contacted with the dose reading(s)
- ❒ Number and types of dosimeters being returned
- ❒ Name of commercial courier for return shipment – overnight shipment is required
- ❒ Source of exposure
- ❒ Any other information you feel pertinent

Enclose a note with the return shipment listing the name and phone number of the person to contact. Mark the outside of the package: EMERGENCY PROCESSING. For shipments received by 10:00 AM Central Daylight Saving Time, Landauer will phone the dose results to the point of contact by 4:30 PM Central Daylight Saving Time. For neutron dosimeters, Landauer will phone the dose results to the point of contact within two business days.

Early Notification of Dose Above Specified Exposure Level

Landauer provides free notification by phone, fax, email or through new online dashboard in myLDR when an individual's dose exceeds 20%of regulatory limits (e.g. deep, lens of eye, shallow, etc.) for any given wear period, or 50% of the regulatory limit year-to-date.

Optional Feature: Set Expsosure Levels for Early Notification

You can elect to set an individual, a subaccount/series, or an entire account at specific notification levels.

Account Maintenance

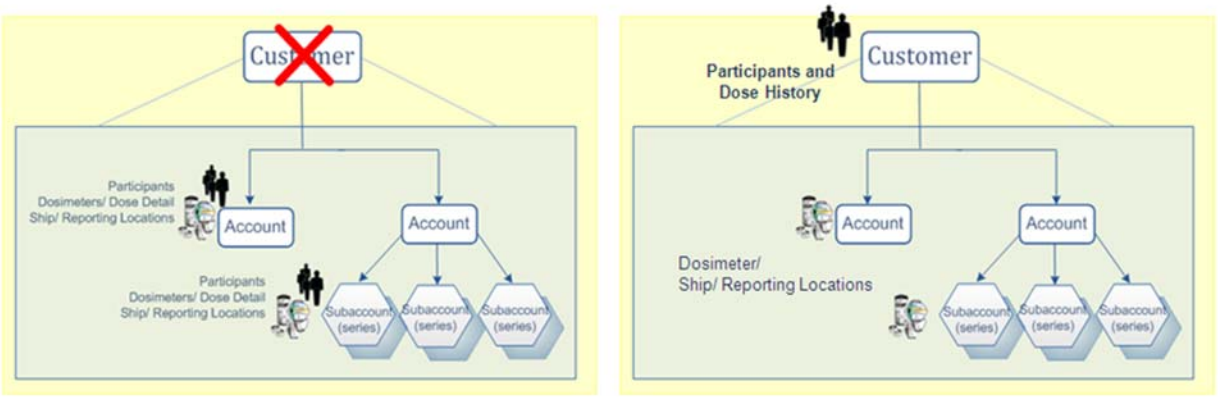
Once your service is established, you can make changes by contacting Customer Service by mail, phone, fax, email or make changes directly online at Landauer's web site, myLDR (See Landauer's Web Site www.landauer.com for log-in information.)

Your packing list that accompanied your shipment can also be used to make changes. Mail packing lists with changes **separately** from your return dosimeter shipment to prevent delays in handling your request.

All written requests for changes should include your account number, subaccount/series (if applicable), participant number, and an authorized signature. Allow us at least 25 days before the next wear date to make changes, **(Landauer notes the deadline on your packing list when your changes must reach Landauer in Glenwood, IL to be effective for the next wear date shipment)**.

Landauer manages your account within a Customer Hierarchy that allows us to manage multiple accounts under one "Customer". Each "Customer" may have one or multiple "Accounts". Each "Account" may have one or multiple "Subaccounts/Series." Each "Account" or "Subaccount/Series" may have one or more exchange frequencies. Each participant has a unique participant number within a "Customer".

Customer Hierarchy



Account Structure Today **New Client Structure**

The new client structure or hierarchy offers many additional advantages:

- ❒ All participant and dose history is stored at the customer level with dosimeters at the location of use being either the account or subaccount/series level
    - o Consolidation method to identify a **C**ustomer, **A**ccount, **S**ubaccount – CAS groups for more consistent pricing and subscription services
- ❒ Enable tracking or trending data within a Customer
    - o **Search** across multiple Accounts and/or Subaccounts within a Customer
        - ▪ Dose history
        - ▪ Client profile
- ❒ Accounts can support unlimited number of frequencies
- ❒ Moving participants from one Account to another is made easier
- ❒ Unique participant number assignments within a customer

Optional Feature: Additional Identification Fields

Participants may carry 11 ID types. Customer can select the primary ID to show on all reports. New customer defined "Customer Reference" ID is available on subaccount/series for structuring your program.

Exchange Frequencies

Exchange intervals from one week up to one year are available dependent on type of dosimeter and dosimetry service:

- ❒ Weekly, each Monday
- ❒ Bi-weekly, alternate Mondays
- ❒ Semi-monthly, 1st and 15th of the month
- ❒ Monthly
- ❒ Bi-monthly, alternate months
- ❒ Quarterly
- ❒ Semi-annual
- ❒ Annual
- ❒ One time only
- ❒ 2 year extension for Emergency Response dosimeters

Service rates may vary with exchange frequency.

Invoice and Payment

Your initial invoice is sent to you approximately one month after your receive your first shipment. Invoices are mailed via US mail and/or can be viewed online at our website.

Products and services are invoiced in advance for the following minimum order periods based on exchange frequency.

- ❒ Weekly service: 13 weeks
- ❒ Biweekly or semi-monthly service: 6 months
- ❒ Monthly, bi-monthly, quarterly, or semi-annual service: one year

Product and services are listed by SKU (stock-keeping unit) number. The initial invoice includes:

- ❒ One-time setup charges for the initial participants
- ❒ Service fees are applicable for shipping: shipping and handling, additional dosimeter fee, single site and multiple site shipments

Actual charges for each shipment such as setup charges for new participants, duplicate reports, optional reports, emergency processing, etc. are entered into your billing file as each shipment is made. At the end of the routine billing cycle, the actual charges are printed on a new invoice and

credit is given for the amount previously invoiced in advance. Services consumed over and above the invoice will be charged at the customer's current rate.

All invoices are due and payable net thirty (30) days after invoice date. Statements are issued monthly on all open accounts thirty (30) or more days past due, and finance charges of 1 1/2% per month (an annual percentage rate of 18%) may be assessed. When making payments, enclose a copy of the invoice, or refer to your account number to ensure proper crediting of your remittance. Payments by credit card can be made online on Landauer's secured website as indicated on your invoice.

The duration of the service contracted shall be the period indicated on the order and shall, without further notice, be renewed for a successive like period of service unless written notification is given by either the buyer or seller at least 30 days prior to the end of any service period.

Landauer's Web Site www.landauer.com

Public Section

Landauer's web site contains resources conveniently available to you anywhere you have access to the Internet. The public section of the web site features information about Landauer, our products and services, useful links to other websites, and FAQ (frequently asked questions). Through the FAQ page you can search the answer database, submit a request to our support staff who will reply to you by email, or log-in to check the status of a request (you can log-in user ID and password for the public section directly on the website).

Landauer Customer Section – my LDR

The customer section is a self-service website where you can managed and report your account data. Log-in to review and edit account information and services. Add, edit, or deactivate subaccounts/series, participants and dosimeters. Track shipments and unreturned dosimeters. Review invoices and payment history. Review and print dosimetry and optional reports, or use a wide range or search criteria to create your own report.

myLDR has secure data encryption offering full and limited log-in access levels that control what account data is displayed and what changes can be made. myLDR is accessible only to Landauer customers who have previously set up a web account with Landauer. An account's dosimetry coordinator/RSO can initiate the creation of a web account on the website at the myLDR Customer Log-In page under New Users by selecting "Create Log-in". Once the Log-in Creation form is successfully submitted, the user ID and password are mailed to the account's reporting address via first class mail to ensure security. Please allow 3 to 7 days for mailing.

Web Account Setup

When you set up your web account on the website, the account data must be entered exactly as it appears on your radiation dosimetry report, including spacing, spelling, and punctuation to be successful.

Browser Requirements

Our website is best viewed with Microsoft® Internet Explorer, PC version 5.5X SP2 or above.

Cookies

The myLDR website requires the use of "cookies" to authenticate your access to the Landauer website. A "cookie" is a small piece of information sent from a web server to a browser to be read back later by the application. No personal information is collected. If you are unable to view screens, please ensure the use of cookies is not restricted through your browser settings.

Optional Feature: Email Notifications

You can have an email sent to you notifying you when the following information is available to view online at Landauer's website:

- ❒ Inbound and outbound shipment tracking information
- ❒ Over exposure information
- ❒ Dosimetry reports
- ❒ Invoices

myLDR offers read only and update capabilities, selective by user, subaccount, etc.

Minimum Dose Equivalent Reported

Dose equivalents for the current monitoring period below the minimum reportable dose are recorded as "M". The minimum reportable dose varies according to the dosimeter type and radiation quality.

Optional Feature: Selected Limit (SL)

You can elect to change the minimum reportable dose for the Luxel+ or InLight dosimeter for photon (x or gamma ray) to 10 mrem (100 uSv). All exposures less than 10 mrem (100 uSv) will appear as "SL". Photon (x and gamma ray) and beta exposures at or more than 10 mrem (100 uSv) would begin reporting at 10 mrem (100 uSv) and report in increments of 10 mrem (100 uSv).

Minimal Dose Equivalent Reported						
Dosimeter Type	M (DDE, SDE)		M (SDE Only)		SL (DDE, SDE)	
	mrem	uSv	mrem	uSv	mrem	uSv
Luxel®+	1	10	-	-	10	100
InLight®	5	50	-	-	10	100
Whole Body Beta	-	-	30	300	-	-
Fetal	1	10	-	-	-	-
Ring	-	-	30	300	-	-
Environmental						
Neutrak® Neutron Fast	20	200	-	-	-	-
Neutrak® Neutron Thermal/Intermediate/Fast	10	100	-	-	-	-

Dosimetry Report

At the end of each wear period, dosimeters returned to our laboratory for processing are analyzed, and a dosimetry report for each account is generated. Reports are printed and mailed to you and/or can be viewed online at our website. Reports cover each wear period and include cumulative totals, personal data and identification, explanatory information and other pertinent data used in the management of a dosimetry program. These reports comply with NRC (Nuclear Regulatory Commission), OSHA (Occupational Safety and Health Administration) or DOE (Department of Energy) regulations. Reports are generated in a standard letter size format, and an explanation page accompanies your reports.

Optional Feature: Duplicate Copies

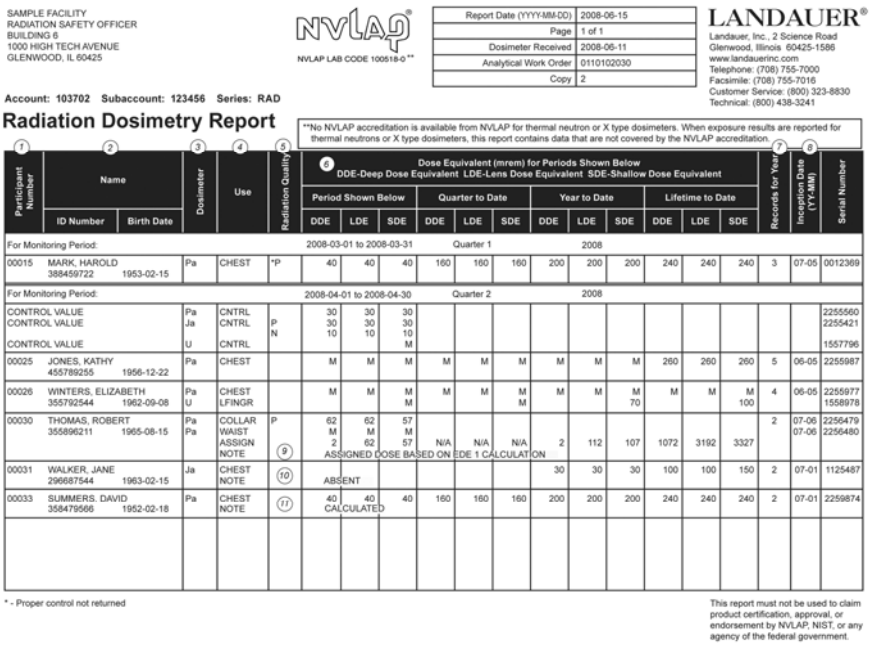
Duplicate copies of dosimetry reports can be mailed on a regular basis to the same address or to another address you designate. [$]

Optional Feature: Access Dosimetry Reports Online

You can access dosimetry reports online at Landauer's website, myLDR. View and print reports with or without suppressed data fields. (See Landauer's Website *www.landauer.com* for log-in information.)

Optional Feature: Paperless

All customers will be able to retrieve multiple **PAPERLESS** reports. Reports will be available on myLDR as soon as they are created.



SAMPLE FACILITY
RADIATION SAFETY OFFICER
BUILDING 6
1000 HIGH TECH AVENUE
GLENWOOD, IL 60425

NVLAP LAB CODE 100518-0 **

Report Date (YYYY-MM-DD)	2008-06-15
Page	1 of 1
Dosimeter Received	2008-06-11
Analytical Work Order	0110102030
Copy	2

LANDAUER®
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www.landauerinc.com
Telephone: (708) 755-7000
Facsimile: (708) 755-7016
Customer Service: (800) 323-8830
Technical: (800) 438-3241

Account: 103702 Subaccount: 123456 Series: RAD

Radiation Dosimetry Report

**No NVLAP accreditation is available from NVLAP for thermal neutron or X type dosimeters. When exposure results are reported for thermal neutrons or X type dosimeters, this report contains data that are not covered by the NVLAP accreditation.

(1) Participant Number	(2) Name / ID Number / Birth Date	(3) Dosimeter	(4) Use	(5) Radiation Quality	(6) Dose Equivalent (mrem) for Periods Shown Below — DDE-Deep Dose Equivalent LDE-Lens Dose Equivalent SDE-Shallow Dose Equivalent: Period Shown Below DDE	LDE	SDE	Quarter to Date DDE	LDE	SDE	Year to Date DDE	LDE	SDE	Lifetime to Date DDE	LDE	SDE	(7) Records for Year	(8) Inception Date (YY-MM)	Serial Number
For Monitoring Period:					2008-03-01 to 2008-03-31			Quarter 1			2008								
00015	MARK, HAROLD 388459722 1953-02-15	Pa	CHEST	*P	40	40	40	160	160	160	200	200	200	240	240	240	3	07-05	0012369
For Monitoring Period:					2008-04-01 to 2008-04-30			Quarter 2			2008								
	CONTROL VALUE	Pa	CNTRL	P	30	30	30												2255560
	CONTROL VALUE	Ja	CNTRL	N	30	30	30												2255421
	CONTROL VALUE	U	CNTRL		10	10	10 M												1557796
00025	JONES, KATHY 455789255 1956-12-22	Pa	CHEST		M	M	M	M	M	M	M	M	M	260	260	260	5	06-05	2255987
00026	WINTERS, ELIZABETH 355792544 1962-09-08	Pa U	CHEST LFINGR		M	M	M M	M	M	M M	M	M	M 70	M	M	M 100	4	06-05	2255977 1558978
00030	THOMAS, ROBERT 355896211 1965-08-15	Pa Pa	COLLAR WAIST ASSIGN NOTE (9)	P	62 M 2 ASSIGNED DOSE BASED ON EDE 1 CALCULATION	62 M 62	57 M 57	N/A	N/A	N/A	2	112	107	1072	3192	3327	2	07-06 07-06	2256479 2256480
00031	WALKER, JANE 296687544 1963-02-15	Ja	CHEST NOTE (10)		ABSENT						30	30	30	100	100	150	2	07-01	1125487
00033	SUMMERS, DAVID 358479566 1952-02-18	Pa	CHEST NOTE (11)		40 CALCULATED	40	40	160	160	160	200	200	200	240	240	240	2	07-01	2259874

* - Proper control not returned

This report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the federal government.

1. Within a "Customer" a unique permanent number assigned by Landauer identifies each individual.

Optional Feature: Sort Order

The default sort order for the dosimetry is by participant number. Data within a report or packing list can also be sorted alphabetically by participant name. If you have a subaccount/series, the default sort is by subaccount/series code and participant number, or you can elect to sort by subaccount/series code and participant name

2. Participant's personal information consisting of name, ID number, and birth date. Participants may have up to four ID types, and a job classification. The participant's gender is maintained with participant information only, and not shown on dosimetry reports.

Optional Feature: Privacy Options

For privacy and/or posting needs, you can request that we suppress fields on the original report (check with your regulatory agency for your specific reporting requirements).

Privacy Options available are:

- ❒ Low: suppress ID number and date of birth
- ❒ Medium: suppress last name, all but last four numbers of SSN and date of birth
- ❒ High: suppress all except participant number

3. Landauer dosimeter type according to monitoring needs:

Dosimeter		Type of Radiation Monitored						Imaging Options
		Photons				Neutrons		
Name	Prefix	X	Gamma	BH Beta High Energy	Beta Low Energy	Fast	Fast/Thermal	Albedo
InLight® with or without Neutrak® Fast or Thermal/Intermediate/Fast	L02P							
	L02J							
	L02T							
InLight with Albedo Neutron detector, with or without Neutrak Fast or Thermal/Intermediate/Fast	L04K							
	L04L							
	L04M							

Dosimeter		Type of Radiation Monitored						Imaging Options
Name	Prefix	Photons			Neutrons			
InLight Environmental	V03P V06P							
Luxel®+ with or without Neutrak Fast or Thermal/Intermediate/Fast	P J T							
Ring, Single TLD	U							

4. The use or location on the body for which the dose is given.

Use	Description	Use	Description
AREA	Area Monitor	LWRIST	Left Wrist Other
CHEST	Chest	OEXTRM	Extremity
CNTRL	Control	OWHBDY	Other Whole Body
COLLAR	Collar	RANKLE	Right Ankle
EYE	Eye	RFINGR	Right Hand Ring
FETAL	Fetal	RUARM	Right Upper Arm
LANKLE	Left Ankle	RULEG	Right Upper Leg
LFINGR	Left Hand Ring	RWRIST	Right Wrist
LUARM	Left Upper Arm	SPECL	Special Purpose
LULEG	Left Upper Leg	UPBACK	Upper Back
LWBACK	Lower Back	WAIST	Waist

"Note" in this column indicates a message explaining any abnormalities, imaging and reanalysis results, or elected optional features, and is printed on a separate line below the dosimeter exposure information.

Landauer reports the dose or record as whole body for a person, not a dosimeter. Landauer's standard dose assessment protocol is to report deep and shallow whole body dose from the highest reading whole body dosimeter, and the lens of eye dose from the dosimeter closest to the eye. "**Assign**" appears when more than one whole body dosimeter is worn, is equal to the highest whole body dosimeter exposure, and is reported as dose of record.

Landauer's whole body dosimeters include the chest, collar, waist, upper or lower back, right or left upper arm, or right or left upper leg. A Landauer designated "other whole body" dosimeter is intended for information purposes only and is not included in the calculation of the whole body dose equivalent for the current monitoring period or cumulative history.

Optional Feature: Fetal Dosimeter

You can track the exposure of a declared pregnant worker and embryo/fetus by adding a fetal dosimeter. The addition of a fetal dosimeter generates an additional page to the standard radiation dosimetry report that reports only the exposure to the declared pregnant worker and the embryo/fetus. [$]

In addition, a monthly summary report is available that reports the estimated dose from conception to declaration (if provided by the customer), the rolling exposure history by month for both the pregnant worker and the embryo/fetus, and the accumulated fetal totals for the gestation period. [$]

5. Radiation type and in some cases energy of radiation contributing to whole body dose equivalent.

Code	Radiation Quality Description (Type and/or Energy)
B	Beta
BH	Beta high energy, e.g., strontium, phosphorus
BL	Beta low energy, e.g., thallion, krypton
BN	Beta, neutron mixture
NF	Neutron fast
NT	Neutron thermal
P	Photon (x or gamma ray)
PB	Photon, beta mixture
PBN	Photon, beta, neutron mixture
PH	Photon high energy greater than 200 keV
PL	Photon low energy less than 40 keV
PM	Photon medium energy 40keV to 200 keV
PN	Photon, neutron mixture

6. The dose equivalent columns report the current and accumulated exposures for deep, lens of eye and shallow dose equivalents.

   - ❒ DDE – Deep dose equivalent applies to external whole-body exposure at a tissue depth of 1 cm (1,000 mg/cm^2)

- ❒ LDE – Eye dose equivalent applies to the external exposure of the lens of eye at a tissue depth of 0.3 cm (300 mg/cm^2)

- ❒ SDE – Shallow dose equivalent applies to the external exposure of the skin or an extremity at a tissue dept of 0.007 cm (7 mg/cm^2) averaged over an area of one square centimeter.

Deep, lens of eye and shallow dose equivalents report for the time frame indicated by "For Monitoring Period." Individual radiation component results and combined totals report in separate lines.

Quarterly accumulated results total dose received within the calendar 3-month time frame. The quarterly columns for bimonthly service display "N/A" (not applicable). Year-to-date accumulation totals dose received from the beginning of the current year to the present reported wear date. Lifetime accumulation totals all dose received from the inception date of dosimeter service to the present reported wear date, and could include earlier dose history if supplied by customer. Dose equivalent results are reported in mrem (millirem) in the US or mSv (millisieverts) internationally.

Internal exposure, if applicable, is summed with Landauer external dose equivalents. Total effective dose equivalent is the sum of both deep dose equivalent (external exposure) and committed effective dose (internal exposure).

Optional Feature: Internal Dose

Landauer can store the following internal dosimetry information when supplied by you: CDE organ, CEDE total, intake quantity by radionuclide, mode of intake, and lung clearance class. Total CEDE is entered if calculated, or is calculated by Landauer. Participant records are updated to reflect the internal contribution to the TODE and the TEDE. Confirmation reports printed the same day reflect data supplied to Landauer, whereas standard dosimetry reports generated by processing external dosimeters reflect the single maximally exposed organ, along with CEDE, TODE and TEDE (For explanation of acronyms, see glossary).

7. The date Landauer began keeping dosimeter records for a given dosimeters for a badged participant on the current account.

8. This example shows how a special dose calculation (EDE 1) is applied to a participant who wears a collar and a waist dosimeter with a lead apron.

Optional Feature: Special Dose Calculations

Special calculations permit departure from Landauer's standard dose assessment protocol in order to provide a more accurate estimation of radiation dose under special circumstances as determined by your Radiation Safety Officer. Special calculations can be applied to an individual, a subaccount/series, or to an entire account. Special dose calculations available for radiation workers who wear lead aprons are:

EDE 1: (Two dosimeters) One dosimeters is worn at the waist level under a lead apron and one dosimeter is worn at the collar level outside the lead apron. 1.5 (Waist DDE) + 0.04 (Collar DDE) = Assigned Deep Dose Equivalent.

(Note: Both waist and collar dosimeters must be returned together. When only one dosimeter is returned without the second, the whole body dose equivalent is calculated per Landauer's standard dose assessment protocol. Then, when the second dosimeter is returned, the dose is recalculated creating an assigned dose equivalent as if both the waist and collar dosimeters were returned at the same time.)

EDE 2: (One dosimeter) One dosimeter is worn outside the lead apron. 0.30 (Collar DDE) = Assigned Deep Dose Equivalent

The "Assigned" line with the EDE 1 and EDE2 calculation results follows all of the original whole body dosimeter doses.

EDE: Effective Dose Equivalent

9. This is an example of what appears on your report when a dosimeter was not returned for processing for the wear period and you have elected to have Absentee Reporting (see following) apply for your account.

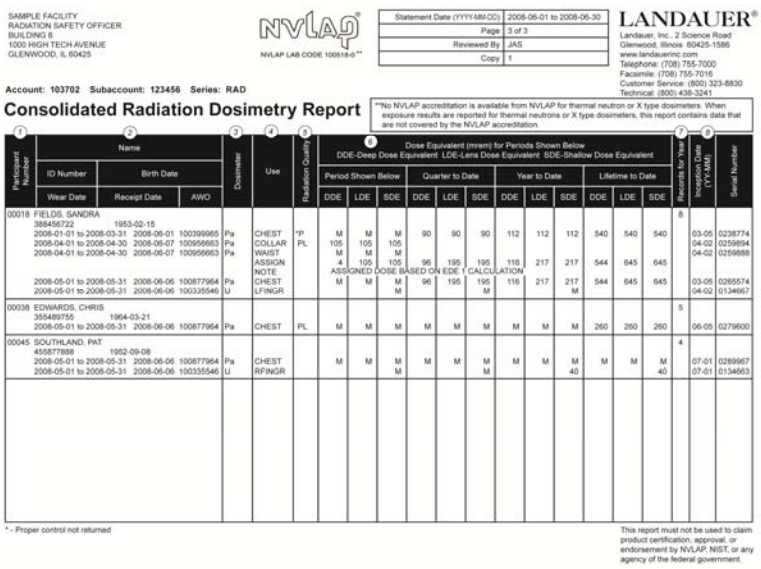
Optional Feature: Absentee Reporting

A dosimeter, if not returned for the wear period, is noted as "absent" on the dosimetry report. This feature is triggered when 80% of the account's dosimeters for the specific wear period are reported. A different percentage level can be requested with the lowest setting being 30% and the maximum setting at 99%..

Optional Feature: ESTimate® Report

Landauer can arrange to automatically calculate an estimated dose for a missing dosimeter for a wear period. This estimate appears in your exposure report, and is automatically updated when the actual dosimeter is returned or a formal declaration of a calculated dose is received. A monthly summary report of outstanding estimates, with an easy method of converting estimates into calculated doses is included in paper format or can be accessed online at Landauer's website. [$]

10. This is an example of a dose for a dosimeter from a calculation given by a customer rather than from a Landauer dosimeter analysis.



SAMPLE FACILITY
RADIATION SAFETY OFFICER
BUILDING 6
1000 HIGH TECH AVENUE
GLENWOOD, IL 60425

NVLAP LAB CODE 100518-0 **

Statement Date (YYYY-MM-DD)	2008-06-01 to 2008-06-30
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LANDAUER®
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Customer Service: (800) 323-8830
Technical: (800) 438-3241

Account: 103702 Subaccount: 123456 Series: RAD

Consolidated Radiation Dosimetry Report

**No NVLAP accreditation is available from NVLAP for thermal neutron or X type dosimeters. When exposure results are reported for thermal neutrons or X type dosimeters, this report contains data that are not covered by the NVLAP accreditation.

Participant Number	Name / ID Number / Birth Date / Wear Date / Receipt Date / AWO	Dosimeter	Use	Radiation Quality	Dose Equivalent (mrem) for Periods Shown Below — DDE-Deep Dose Equivalent LDE-Lens Dose Equivalent SDE-Shallow Dose Equivalent												Records for Year	Inception Date (YY-MM)	Serial Number
					Period Shown Below			Quarter to Date			Year to Date			Lifetime to Date					
					DDE	LDE	SDE	DDE	LDE	SDE	DDE	LDE	SDE	DDE	LDE	SDE			
00018	FIELDS, SANDRA																8		
	388456722 1953-02-15																		
	2008-01-01 to 2008-03-31 2008-06-01 100399965	Pa	CHEST	*P	M	M	M	90	90	90	112	112	112	540	540	540		03-05	0238774
	2008-04-01 to 2008-04-30 2008-06-07 100956663	Pa	COLLAR	PL	105	105	105											04-02	0259894
	2008-04-01 to 2008-04-30 2008-06-07 100956663	Pa	WAIST		M	M	M											04-02	0259888
			ASSIGN		4	105	105	96	195	195	116	217	217	544	645	645			
			NOTE		ASSIGNED DOSE BASED ON EDE T CALCULATION														
	2008-05-01 to 2008-05-31 2008-06-06 100877964	Pa	CHEST		M	M	M	96	195	195	116	217	217	544	645	645		03-05	0265574
	2008-05-01 to 2008-05-31 2008-06-06 100335546	U	LFINGR				M			M			M					04-02	0134667
00038	EDWARDS, CHRIS																5		
	355489755 1964-03-21																		
	2008-05-01 to 2008-05-31 2008-06-06 100877964	Pa	CHEST	PL	M	M	M	M	M	M	M	M	M	260	260	260		06-05	0279600
00045	SOUTHLAND, PAT																4		
	455877888 1952-09-08																		
	2008-05-01 to 2008-05-31 2008-06-06 100877964	Pa	CHEST		M	M	M	M	M	M	M	M	M	M	M	M		07-01	0289967
	2008-05-01 to 2008-05-31 2008-06-06 100335546	U	RFINGR				M			M			40			40		07-01	0134663

* - Proper control not returned

This report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the federal government.

Supplementary U.K. Occupational Dosimetry Report Information

Radiation type, and in some cases energy of radiation contributing to whole body dose equivalent.

Code	Radiation Quality Description (Type and/or Energy)
BK	Krypton beta
BS	Strontium beta
BT	Thallium beta
BU	Uranium beta
NF	Neutron fast
NT	Neutron thermal
P	Photon (x or gamma ray)
PH	Photon high energy, greater than 100 keV
PL	Photon low energy, less than 100 keV
BN	Beta and neutron exposure
PB	X-ray or gamma and beta exposure
PN	X-ray or gamma and neutron exposure
PBN	X-ray or gamma, beta, and neutron exposure

Cumulative Totals: Quarterly accumulated results total dose received within the calendar 3 month time frame. (Note: Quarterly accumulated columns for bimonthly service display "Not applicable.") Year to date accumulation totals dose received from the beginning of the current year to present wear date. Permanent accumulation totals all dose received from inception date of dosimeter service to present reported wear date.

Adjustments: Adjustments made to cumulative totals with this or previous report at customer request.

A Additions

B Subtractions

C Additions and subtractions

D Dosage data supplied by customer for period prior

E As D, additional changes have also been made

F Previous lifetime exposure supplied by customer

G As F, additional changes have also been made

Optional Reports

In addition to our standard radiation dosimetry report, the following optional reports and services designed to help simplify the management of your dosimetry program are available. [$]

Compliance – Individual Reporting Requirements

Equivalent Form 4

An annual report detailing cumulative occupational exposure history for an individual. The report shows dose since inception of continuous Landauer service and, if provided, lists prior employer dose records. Equivalent to NRC Form 4, this report is used as a tool for transmitting exposure data from one licensee (employer) to another to gather lifetime histories for all workers requiring monitoring.

Equivalent Form 5

A report detailing dose history for an individual for the year at a given location. The report contains all the information required by NRC Form 5, which satisfies the requirement for an annual report to workers, the NRC, and other regulatory bodies (check with your regulatory agency for your specific requirements). Reports are generated annually after the close of a calendar year or quarterly with current data up to the last wear period reported.

Termination Report Service

Service provides an Equivalent Form 5 for presentation to the worker when an individual is deleted from Landauer service. Overnight report generation is available upon request. Change incurs only upon generation of the report.

Exposure Management Services

Statistical Summary

An annual report summarizing an organization's range of exposure on a single page. The summary breaks out deep dose exposure levels from "no measurable exposure" to increments above regulatory limits and shows how many workers are in each range.

ESTimate®

A monthly service that computes an estimated dose for a missing body, eye, or ring dosimeter for a wear period. The estimated dose automatically appears in exposure reports identified as an estimate, and is used to compute the assigned dose. A monthly report lists all outstanding estimates together with dosimeter data used to compute the estimated doses. Other dosimeters worn by the individual for the wear period are included in the report for context to provide all the essential information needed to easily decide what calculated dose is appropriate. ESTimate is an excellent way to track exposure trends and ALARA levels when a dosimeter is late or missing; available in paper format or online at Landauer's website.

Fetal Monitor Service

A monthly service that tracks exposure of a declared pregnant worker and embryo/fetus by reporting exposure of the mother wearing a whole body dosimeter and an additional fetal dosimeter. The report lists estimated dose from conception to declaration, rolling exposure history by month for both pregnant worker and the embryo/fetus, and accumulated fetus totals for the gestation period. The addition of a fetal dosimeter also generates an additional page to the standard radiation dosimetry report that reports only the exposure to the declared pregnant worker and the embryo/fetus.

Multiple Employer Total Exposure Report (METER™)

A monthly report that lists individuals who have had activity in other Landauer accounts during the reporting year. Each individual's exposures are summedacross all facilities to help compare the totals with regulatory limits. METER helps to satisfy the information required for the NRC's and state agencies' requirement that occupational exposures be controlled within limits for all sources of on the job exposure.

REIRS and REMIT Reporting

This service provides year end exposure data compatible with the REMIT program used to electronically transmit information to NRC's REIRS database.

ALARA Compliance

Personalized ALARA Memos

ALARA memo service generates a memo for each individual whose dose levels exceeded the quarter's ALARA (As Low As Reasonably Achievable) levels. ALARA levels 1 and 2 can be set or NRC guidelines can be used. The personalized memo stating the exposure and level exceeded is sent to the radiation safety officer for review, and can then be presented to the individual. Level 2 memos include a questionnaire to help investigate the exposure.

ALARA Detailed Recaps

An annual and quarterly ALARA report that lists all individuals with their exposure histories. Quarterly reports show which individuals exceeded ALARA Levels 1 and 2 for the quarter and year to date, while annual reports quickly show trends by individuals and departments for the year. Reports track both individual and collective dose. ALARA levels can be set or NRC guidelines can be used.

Report Management Services

Reports on CD-ROM

This service is an annual accumulation of reports on CD-ROM created after the close of a calendar year. Digital storage gives you the opportunity to save file space, and a search function allows you to browse by account number, series, participant name or number and wear date to find the report you want to view and print. Reports that are currently available on CD-ROM are Standard Dosimetry Reports, Equivalent Form 5, and Termination Reports.

Special and Other Services

Landauer can support special dosimetry studies where conventional personnel dosimetry is inappropriate. Through Special Services, much tighter tolerances, special calibrations and other non-routine functions can be provided. Please contact InLight Customer Service for more information.

Luxel®+ Administrative Features

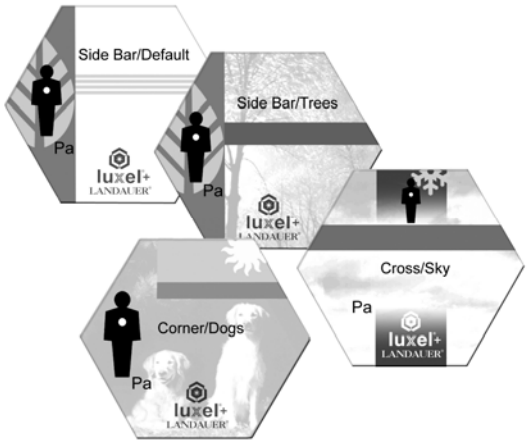
The dosimeter's basic design incorporates on the face of the dosimeter your account name, the participant name, and a dosimeter placement icon indicating correct placement of the dosimeter. The subaccount/series name is printed over a gray line graphic (default) or can be color coded for easy identification in a choice of six different colors (see Optional Feature: Shipments to Multiple Sites, p. 5). The graphic formats change in color with each exchange frequency, and each season has its own unique icon. The account and participant numbers, wear date, placement

location, serial number, and the dosimeter and component bar codes, all ensuring chain of custody, appear on the back of the dosimeter (see p. 8).

Optional Feature: Background and Graphic Format Options

Choose between any combination of four background options and three graphic formats. Background options are no background (default), Dogs, Sky or Trees. Graphic formats are Side Bar (default), Corner or Cross. The graphic format color sequence can be color coded in a choice of six different colors.

Background and Graphic Format Option Examples



Optional Feature: Specialized Holders

Specialized holders available: [$]

- ❒ for use in magnetic environments
- ❒ Luxel wrist dosimeter with Velcro strap for extremity measurements
- ❒ attached to Velcro squares for vertical substrate area applications

Luxel® + Dosimeter Specifications

The Luxel+ dosimeter measures radiation exposure due to x, gamma and beta radiation with optically stimulated luminescence (OSL) technology. The OSL radiation detector inside the dosimeter is a thin strip of specially formulated aluminum oxide (Al_2O_3:C) crystalline material. During analysis in our laboratory, the Al_2O_3:C strip is stimulated with selected frequencies of laser light causing it to luminesce in proportion to the amount of radiation exposure and the intensity of stimulation light. The luminescence measured during analysis is applied to a dose algorithm that relies on the response ratios between different filter positions within the dosimeter to discriminate between beta and photon (x and gamma) radiation fields to determine exposure results. Dose equivalents arising from exposures to photons (x or gamma rays) will have a deep, lens of eye and shallow value reported. Depending on the energy of the x or gamma rays, these values mayor may not be equal. Beta exposures are reported only as a shallow dose equivalent. Luxel+ is an integrated, self-contained packet that comes preloaded, incorporating the Ab03:C strip sandwiched within a multi-element filter pack that is heat sealed within a laminated, light-

tight paper wrapper. All of these components and the optional Neutrak CR-39 are sealed inside a tamper-proof plastic blister pack to eliminate possible mishandling, light leakage or lost detection elements.

Luxel + may be used for up to one year. It is unaffected by heat, moisture, and pressure when he clear blister pack is uncompromised.

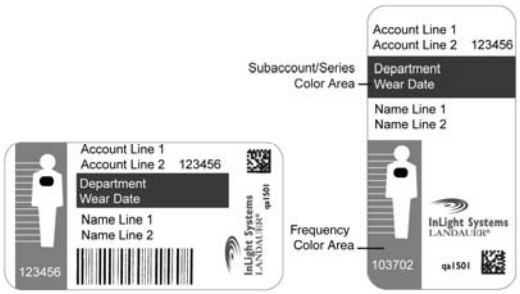
Radiation Type	Energy Range	Minimum Dose Equivalent Reported	Maximum Dose Measurement
Photon (x or gamma ray)	5 keV to 40 MeV	1 mrem (10 uSv)	1000 rem (10 Sv)
Beta particle	150 keV to 10 MeV (Expressed as average energy)	10 mrem (100 uSv)	1000 rem (10 Sv)
Neutron Fast (optional CR-39)	40 keV to 40 MeV	20 mrem (200 uSv)	25 rem (250 mSv)
Neutron Thermal/Intermediate/Fast (optional CR-39)	0.25 eV to 40 MeV	10 mrem (100 uSv)	25 rem (250 mSv)

Accreditations, Approvals, Licenses

- ❒ NVLAP® (NVLAP Lab Code 100518-0) for Whole Body (ANSI HPS N13.11-2009) in subcategory "General" in all categories including VIA when the fast neutron component is added; and for extremity (ANSI HPS N13.32-2008). No accreditation is available from NVLAP for thermal neutron dosimeters.
- ❒ CNSC (Canadian Nuclear Safety Commission) Dosimetry Service License.
- ❒ HSE (Health and Safety Executive) United Kingdom approved for Whole Body (OSL) and Whole Body Neutrons.

InLight® Administrative Features

InLight's design incorporates on the face of the dosimeter your account name, the participant name, and a dosimeter placement icon indicating correct placement of the dosimeter. The frequency color area changes in color with each exchange frequency. Labels may be vertical or horizontal.



InLight Dosimeter Specifications

InLight dosimeters measure x, gamma, and beta radiation exposure with aluminum oxide detectors (Al_2O_3:C) read out by optically stimulated luminescence (OSL) technology. The read out process uses a light emitting diode (LED) array to stimulate the detectors, and the light emitted by the OSL material is detected and measured by the photomultiplier tube (PMT) using a high sensitivity photon counting system. The amount of light released during optical stimulation is directly proportional to the radiation dose and the intensity of stimulation light. A dose calculation algorithm is then applied to the measurement to determine exposure results. The OSL read out process allows for dose verification through complete reanalysis. The InLight dosimeter is built on an assembly of a case component with filters along with a detector slide component. Both the case and slide are uniquely bar coded with serial numbers for chain of custody and sensitivity identification.

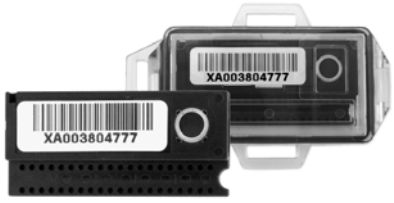
The InLight carrier is designed to accommodate a case and slide, the optional Neutrak~ CR-39 component for neutron detection (see p. 31), and the optional imaging component. InLight dosimeters are not affected by heat, humidity, or chemical solvents. The Al_2O_3:C detector material does not respond to neutron radiation, and the packaging material is sufficient to shield the dosimeter from alpha and optical radiations.

Radiation Type	Energy Range	Minimum Dose Equivalent Reported	Maximum Dose Measurement
Photon (x or gamma ray)	5 keV to 20 MeV	5 mrem (50 uSv)	1000 rem (10 Sv)
Beta Particle	150 keV to 10 MeV (expressed as average energy)	10 mrem (100 uSv)	1000 rem (10 Sv)
Neutron Fast (optional CR-39)	40 keV to 40 MeV	20 mrem (200 uSv)	25 rem (250 mSv)
Neutron Thermal/Intermediate/Fast (optional CR-39)	0.25 eV to 40 MeV	10 mrem (100 uSv)	25 rem (250 mSv)
Albedo Neutron (optional albedo slide)			

InLight is accredited by NVLAP® (NVLAP Lab Code 100518-0) for Whole Body (ANSI HPS N13.11-2009) in comprehensive subcategory "General" in all categories including VIA when fast neutron component is added. No accreditation is available from NVLAP for thermal neutron dosimeters.

InLight EX and EX9 Environmental Dosimeter Specifications

The InLight Environmental Dosimeter is built on an assembly of a case component with filters along with a Al_2O_3:C detector slide component. The case and slide are sealed in a robust vinyl pouch. Both the case and slide are uniquely bar coded with serial numbers for chain of custody and sensitivity identification.



Radiation Type	Energy Range	Minimum Ambient Dose Equivalent Reported	Maximum Dose Measurement
Photon (x or gamma ray)	5 keV to 20 MeV	5 mrem (50 uSv) High Sensitivity: 0.1 mrem (1 uSv)	1000 rem (10 Sv)
Beta Particle	150 keV to 10 MeV (expressed as average energy)	10 mrem (100 uSv) High Sensitivity: 20 mrem (200 uSv)	1000 rem (10 Sv)

The Inlight Environmental Dosimeter fully meets ANSI N545-1977, NRC Regulatory Guide 4.13, and HPS Draft Standard N13.29 for environmental dosimetry.

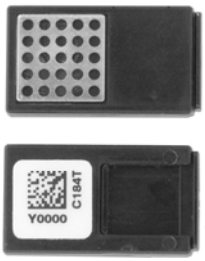
Luxel® + InLight® Imaging

The Al_2O_3:C aluminum oxide detector can be restimulated numerous times to confirm the accuracy of a radiation dose measurement. A full reanalysis is automatically performed for every measurement yielding a dose in excess of 500 mrem (5 mSv).

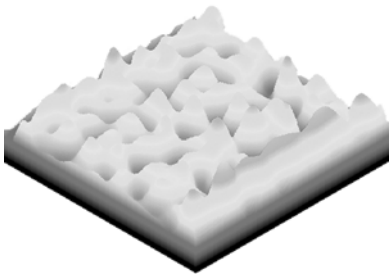
The Luxel+ filter pack imaging area and the InLight imaging component renders unique filter patterns that provide qualitative information about conditions during exposure. Imaging to identify static, dynamic, or contamination conditions is automatically performed for all beta and low-energy photon measurements yielding a dose in excess of 500 mrem (5 mSv). Imaging capabilities are inconclusive at energies exceeding 150 keV.

Luxel + Imaging Area

InLight Imaging Component



A dynamic exposure image indicates the dosimeter was moving at the time of exposure. This is verified by the blurred grid patterns in the filter pack imaging area. A dynamic exposure implies that the dosimeter was worn at the time of exposure, and the reported dose is valid.



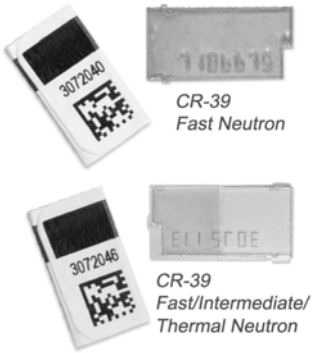
Optional Feature: Reanalysis or Imaging at Less than 500 mrem (5 mSv)

Reanalysis or imaging at doses less than 500 rem (5 mSv) can be requested. Imaging is not available for doses less than 50 mrem (500 uSv).

After reanalysis and/or imaging, a note will appear at the bottom of the dosimetry report indicating:

- ❒ The second read agrees with the reported dose
- ❒ The exposure was static, dynamic or indicates contamination
- ❒ An angular exposure is apparent
- ❒ The dosimeter was partially shielded
- ❒ The reported dose is the best possible evaluation
- ❒ No evaluation is possible

Neutrak® Dosimeter Specifications



The Neutrak detector is a CR-39 (allyl diglycol carbonate) based, solid-state nuclear track detector that measures exposure due to neutrons. It is not sensitive to x, beta or gamma radiation, and can be sealed inside the Luxel®+ dosimeter plastic blister pack in a one-piece design, the InLight® holder in a one-piece design, or can be packaged specifically for neutron detection only. The CR-39 is laser engraved for permanent identification to assure chain-of custody.

The fast neutron option uses a polyethylene radiator for fast neutrons that records recoil protons resulting from neutron interactions in the dosimeter. The thermal/intermediate neutron option has a dosimeter design intended for fast, intermediate, and thermal neutrons. The left area of the chip uses a polyethylene radiator for fast neutrons while the right area uses a boron loaded Teflon® radiator for fast, intermediate, and thermal neutrons that also records alpha particles resulting from neutron interactions in the dosimeter.

During analysis in our laboratory, the CR-39 is etched in a chemical bath to enlarge exposure tracks. The fast neutron dose is measured by counting the tracks generated as a result of the proton recoil with the polyethylene radiator, while the thermal/intermediate dose is measured by counting the alpha tracks generated with the boron radiator. One value is reported for deep, lens of eye and shallow dose equivalent.

Neutron Type	Energy Range	Minimum Dose Equivalent Reported	Maximum Dose Measurement
Fast	40 keV to 40 MeV	20 mrem (200 uSv)	25 rem (250 mSv)
Thermal/Intermediate/Fast	0.25 eV to 40 MeV	10 mrem (100 uSv)	25 rem (250 mSv)

Accreditations, Approvals, Licenses

- ❒ NVLAP® (NVLAP Lab Code 100518-0) for Whole Body (ANSI HPS N13.11-2009) in subcategory "General" in all categories including VIA when the fast neutron component is added; and for extremity (ANSI HPS N13.32-2008). No accreditation is available from NVLAP for thermal neutron dosimeters.
- ❒ CNSC (Canadian Nuclear Safety Commission) Dosimetry Service License.
- ❒ HSE (Health and Safety Executive) United Kingdom approved for Whole Body (OSL) and Whole Body Neutrons.

Ring Dosimeter Specifications

Landauer's thermoluminescent (TLD) ring dosimeter measures radiation exposure due to x, beta, and gamma radiation with a lithium fluoride chip.

The TLD chip is safely encapsulated inside the identification cover. No separation of the TLD from the cover is possible, so the identity of the chip and the wearer is always maintained. The cover and TLD are independent of the ring base.

Identification on the cover is laser engraved preventing the print from smearing, peeling, or washing off. Rings can be worn in dry or wet working conditions, and cold sterilized without compromising the integrity of the dosimeter. Information engraved on the ring cover is as shown in the Ring Dosimetry section.

Rings are available in sizes small, medium, large, and extra-large. Unless otherwise instructed, the medium size is sent. The color of the ring base changes (red, blue, or black) each wear period to help identify wear dates.

During analysis in our laboratory, the TLD chip is heated causing it to become luminescent in proportion to the amount of radiation exposure. The luminescence is measured and a report of exposure results is generated. The glow curve of the readout that permits a more conclusive evaluation of radiation exposure can be retrieved and analyzed before the exposure report is generated if any anomaly appears.

The sum of the high energy beta, gamma and x radiation is reported as a shallow dose. If the ring dosimeter is exposed to radiation other than x-ray or gamma over 20 keV or high energy beta, the value recorded may require further interpretation on your part. Landauer will furnish, on request, adjustment factors for any specified energy level.

Radiation Type	Energy Range	Minimal Dose Equivalent Reported	Maximum Dose Measurement
Photon (x or gamma ray)	Greater than 15 keV	30 mrem (300 uSv)	1000 rem (10 Sv)
Beta particle	Greater than 200 keV (expressed as average energy)	40 mrem (400 uSv)	1000 rem (10 Sv)

Rings are accredited in extremity dosimetry categories I through VII by the National Institute of Standards and Technology through NVLAP® (NVLAP Lab Code 100518-0).

Glossary of Selected Terms from CFR 20, Chapter 10

(Except as Noted)

ALARA - "As Low As Reasonably Achievable."

ALI (Annual Limit on intake) is a derived limit for the amount of radioactive material taken into the body of a worker by inhalation or ingestion in a year that results in a

CEDE of 5 rems or a CDE of 50 rems, whichever is more restrictive.

CDE (Committed dose equivalent) is the dose equivalent to an organ or tissue that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

CEDE (Committed effective dose equivalent) is the sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to theses bodies or tissues.

DAC (Derived air concentration) is the concentration of a given radionuclide in air which, if breathed for a working year of 2,000 hours under conditions of light work, results in an intake of one ALI.

DDE (Deep dose equivalent) applies to external whole body exposure, is the dose equivalent at a tissue depth of 1 centimeter.

DE (Dose equivalent) is the product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest. The units of dose equivalent are the rem and sievert (Sv).

External dose is that portion of the dose equivalent received from radiation sources outside the body.

Internal dose is the portion of the dose equivalent received from radioactive material taken into the body.

LDE (Eye dose equivalent) refers to the external exposure of the lens of the eye and is taken as the dose equivalent at a tissue depth of 0.3 centimeter.

SDE (Shallow dose equivalent) applies to the external exposure of the skin or an extremity, and is the dose equivalent at a tissue depth of 0.007 centimeter averaged over an area of 1 square centimeter.

TEDE (Total Effective Dose Equivalent) is the sum of the deep dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

TODE (Total Organ Dose Equivalent) is the sum of the deep dose equivalent and the committed effective dose equivalent to the organ receiving the highest dose as described in 10 CFR 20.2106(a)(6)